Perspective

Sanitation Systems (/perspective/sanitation-systems-perspective)

Section

Sanitation Technologies (/sanitation-systems/sanitation-technologies)

Factsheet

Horizontal Subsurface Flow Constructed Wetland

العربية (/ar/sanitation-systems/sanitation-technologies/horizontal-subsurface-flow-constructed-wetland)

Applicable to

System 1 (/humanitarian-crises/rural-settings/sanitation/sanitation-systems/system-1%3A-single-pit-system)

System 6 (/humanitarian-crises/rural-settings/sanitation/sanitation-systems/system-6%3A-blackwater-treatment-system-with-infiltration)

System 7 (/humanitarian-crises/rural-settings/sanitation/sanitation-systems/system-7%3A-blackwater-treatment-system-with-effluent-transport)

System 8 (/humanitarian-crises/urban-settings

Application level

- City
- Household
- Neighborhood

Management level

- Household
- Public
- Shared

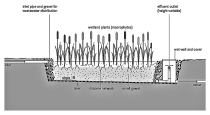
Inputs

- Blackwater
- Brownwater
- Greywater
- Effluent

Outputs

- Effluent
- Biomass

/sanitation
/sanitation-systems
/system-8%3A-
blackwater-transport-
to-%28semi-%29-
centralized-
treatment-system)
System 9
(/sanitation-systems
/sanitation-systems
/system-9%3A-
sewerage-system-
with-urine-diversion)



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Adapted from

Compendium of Sanitation Systems and Technologies. 2nd Revised Edition (/node/5587)

Executive Summary

A horizontal subsurface flow constructed wetlandis a large gravel and sand-filled basin that is planted with wetland vegetation. As wastewater flows horizontally through the basin, the filter material filters out particles and microorganisms degrade the organics.

Advantages

- High reduction of BOD, suspended solids and pathogens
- Does not have the mosquito problems of the Free-Water Surface Constructed Wetland
- No electrical energy is required
- Low operating costs

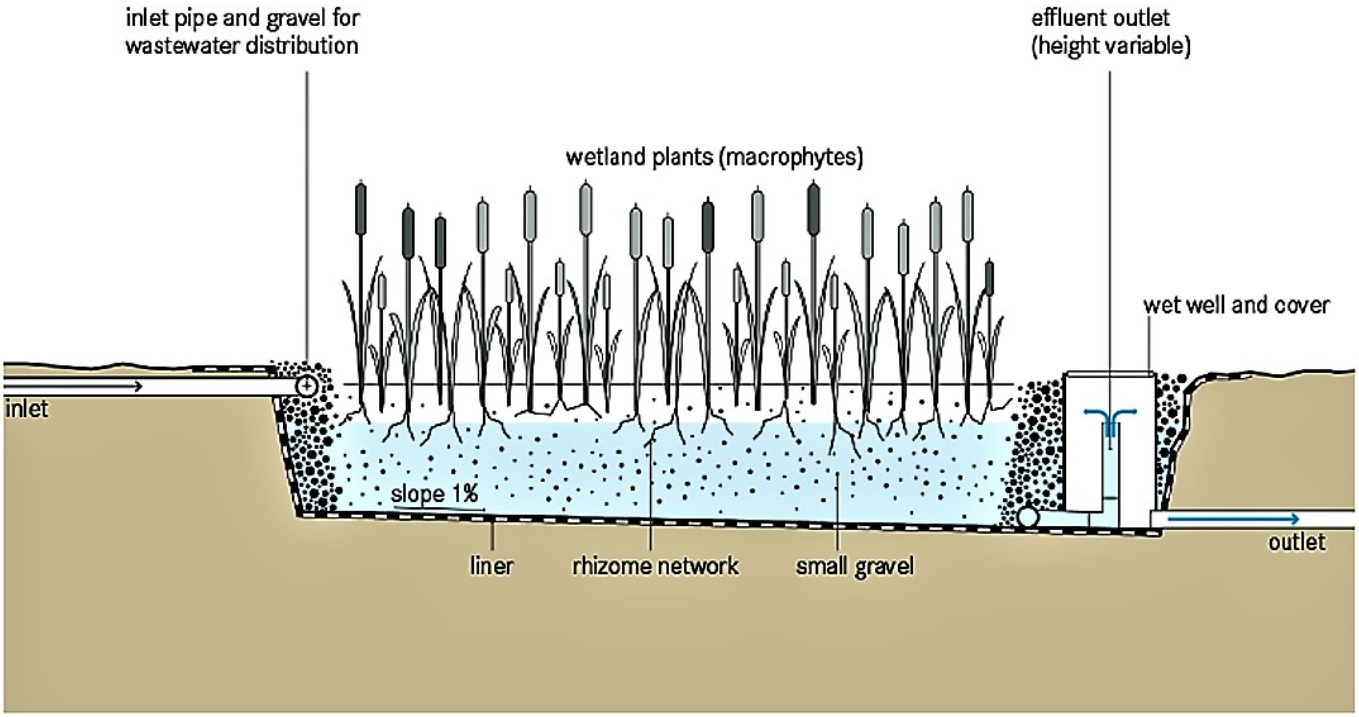
Disadvantages

- Requires a large land area
- Little nutrient removal
- Risk of clogging, depending on pre- and primary treatment
- Long start-up time to work at full capacity
- Requires expert design and construction supervision

In	Out
Blackwater, Greywater, Brownwater	Fertigation Water, Treated Water

Introduction

The filter media acts as a filter for removing solids, a fixed surface upon which bacteria can attach, and a base for the vegetation. Although facultative and anaerobic bacteria degrade most organics, the vegetation transfers a small amount of oxygen to the root zone so that aerobic bacteria can colonise the area and degrade organics as well. The plant roots play an important role in maintaining the permeability of the filter.



Schematic of the Horizontal Subsurface Flow Constructed Wetland. Source: TILLEY et al. (2014)

Design Considerations

The design of a horizontal subsurface flow constructed wetland depends on the treatment target and the amount and quality of the influent. It includes decisions about the amount of parallel flow paths and compartmentation. The removal efficiency of the wetland is a function of the surface area (length multiplied by width), while the cross-sectional area (width multiplied by depth) determines the maximum possible flow. Generally, a surface area of about 5 to 10 m2 per person equivalent is required.

Pre- and primary treatment is essential to prevent clogging and ensure efficient treatment. The influent can be aerated by an inlet cascade to support oxygen-dependent processes, such as BOD reduction and nitrification.The bed should be lined with an impermeable liner (clay or geotextile) to prevent leaching. It should be wide and shallow so that the flow path of the water in contact with vegetation roots is maximized.

A wide inlet zone should be used to evenly distribute the flow. A well-designed inlet that allows for even distribution is important to prevent short-circuiting. The outlet should be variable so that the water surface can be adjusted to optimize treatment performance.

Small, round, evenly sized gravel (3 to 32 mm in diameter) is most commonly used to fill the bed to a depth of 0.5 to 1 m. To limit clogging, the gravel should be clean and free of fines. Sand is also acceptable, but is more prone to clogging than gravel. In recent years, alternative filter materials, such as PET, have been successfully used. The water level in the wetland is maintained at 5 to 15 cm below the surface to ensure subsurface flow. Any native plant with deep, wide roots that can grow in the wet, nutrient-rich environment is appropriate. *Phragmites australis* (reed) is a common choice because it forms horizontal rhizomes that penetrate the entire filter depth.

Health Aspects/Acceptance

Significant pathogen removal is accomplished by natural decay, predation by higher organisms, and filtration. As the water flows below the surface, any contact of pathogenic organisms with humans and wildlife is minimized. The risk of mosquito breeding is reduced since there is no standing water compared to the risk associated with **Free-Water Surface Constructed Wetlands (/factsheet/free-water-surface-cw)**. The wetland is aesthetically pleasing and can be integrated into wild areas or parklands.

Operation & Maintenance

During the first growing season, it is important to remove weeds that can compete with the planted wetland vegetation. With time, the gravel will become clogged with accumulated solids and bacterial film. The filter material at the inlet zone will require replacement every 10 or more years. Maintenance activities should focus on ensuring that primary treatment is effective at reducing the concentration of solids in the wastewater before it enters the wetland. Maintenance should also ensure that trees do not grow in the area as the roots can harm the liner.

Applicability

Clogging is a common problem and, therefore, the influent should be well settled with primary treatment before flowing into the wetland. This technology is not appropriate for untreated domestic wastewater (i.e. blackwater). It is a good treatment for communities that have primary treatment (e.g., **Septic Tanks (/factsheet/septic-tank)**).

The horizontal subsurface flow constructed wetland is a good option where land is cheap and available. Depending on the volume of the water and the corresponding area requirement of the wetland, it can be appropriate for small sections of urban areas, as well as for peri-urban and rural communities. It can also be designed for single households.

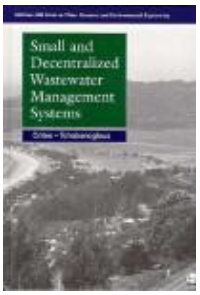
This technology is best suited for warm climates, but it can be designed to tolerate some freezing and periods of low biological activity. If the effluent is to be reused, the losses due to high evapotranspiration rates could be a drawback of this technology, depending on the climate.

Media PPT

Constructed Wetlands (PPT) (/media/3)

Library References

Small and Decentralized Wastewater Management Systems



Decentralised wastewater management presents a comprehensive approach to the design of both conventional and innovative systems for the treatment and disposal of wastewater or the reuse of treaded effluent. Smaller treatment plants, which are the concern of most new engineers, are the primary focus of this book.

CRITES, R. TCHOBANOGLOUS, G. (1998): Small and Decentralized Wastewater Management Systems. New York: The McGraw-Hill Companies Inc

Technology Review of Constructed Wetlands

This publication intends to help spread awareness and knowledge about the technology of subsurface flow constructed wetlands in developing countries. Constructed wetlands (CWs) can be used as part of decentralised wastewater treatment systems, due to their “robust”, “low-tech” nature with none or few moving parts (pumps) and relatively low operational requirements. CWs can be used for the treatment of domestic and municipal wastewater or greywater, and play an important role in many ecological sanitation (ecosan) concepts.

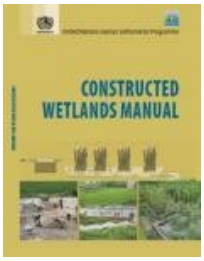
HOFFMANN, H. PLATZER, C. WINKER, M. MUENCH, E. von GIZ (2011): Technology Review of Constructed Wetlands. Subsurface Flow Constructed Wetlands for Greywater and Domestic Wastewater Treatment. Eschborn: Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH **URL (https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/930)** [Accessed: 01.06.2019]

Treatment Wetlands. 2nd Edition

This book supports in making informed decisions regarding wetland design.

KADLEC, R. H. WALLACE, S. D. (2009): Treatment Wetlands. 2nd Edition. Boca Raton: CRC Press, Taylor & Francis Group **URL (https://www.researchgate.net/publication/284194314_Treatment_Wetlands_2nd_Ed_CRC_Press)** [Accessed: 09.06.2019]

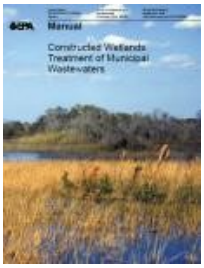
Constructed Wetlands Manual



This manual has been prepared as a general guide to the design, construction, operation and maintenance of constructed wetlands for the treatment of domestic wastewater as well as introduction to the design of constructed wetland for sludge drying.

UN-HABITAT (2008): Constructed Wetlands Manual. Kathmandu: UN-HABITAT, Water for Asian Cities Program **URL (http://www.un.org.np/sites/default/files /CWManual.pdf)** [Accessed: 15.02.2012]

Manual – Constructed Wetlands Treatment of Municipal Wastewater



This manual discusses the capabilities of constructed wetlands, a functional design approach, and the management requirements to achieve the designed purpose. The manual also attempts to put the proper perspective on the appropriate use, design and performance of constructed wetlands. Furthermore, the document contains two case studies.

U.S. EPA (1999): Manual – Constructed Wetlands Treatment of Municipal Wastewater. Washington D.C.: United States: Environmental Protection Agency (EPA) **URL (https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=64144&Lab=NRMRL)** [Accessed: 09.06.2019]